

XIII. *Further notes on the terminal segments of Aculeate Hymenoptera.* By EDWARD SAUNDERS, F.L.S.

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PLATE XIII.

IN the volume of our 'Transactions' for 1882 I made some remarks on the terminal segments of the genus *Prosopis*, and pointed out that good specific characters were obtainable from an examination of the 8th ventral segments of the ♂, as well as of the genital armature. Since then I have extended my observations to the other genera of the Anthophila, as well as to those of the Fossores, Heterogyna, and Diploptera, and I find so many interesting features disclosed by these examinations that I thought a few remarks on them might be interesting to the members of the Society.

I may observe, in the first place, that the 8th ventral segment is always distinctly present in the Aculeata, and I have in several cases removed it entire, so as to show the connection between the valves. As a rule it varies more in form than the 7th, especially as regards its ventral valve. It is the ventral valve of the 8th segment which bears the three spines in *Scolia*, the up-turned spine in *Myzine* and *Methoca*, and the spoon-shaped apical process in *Andrena* and its allies; and yet the presence of this 8th segment seems to have been ignored by most hymenopterists, Klug and a few others being the exceptions, or to have been mistaken for that of the 7th, where this latter is hidden beneath the 6th, as is the case in many genera, such as *Pompilus*, *Andrena*, &c. In many others the 8th segment is entirely hidden, and can only be observed after dissection; but even then, as in *Prosopis*, it exhibits great variety of form; there is one character whereby the ventral valve of the 8th may in most cases be known, *viz.*, that it is produced basally in the centre, whereas the 7th is only produced basally at the sides. The dorsal valve of the 8th is generally more or less membranous or corneous,

and is rarely visible; as a rule it fits into and is of the same shape as the 7th, but there is an important modification of it in the Heterogyna, *Mutillidæ* and *Pompilidæ*, and the genus *Astata*, where it bears at its apex two little pilose processes of a somewhat palpiform nature (see Pl. XIII., figs. 1a, 2a, 3a, &c.): these are generally visible beyond the apex of the 7th segment, and will be found more fully described under the head Heterogyna, &c., further on, where the distinctive features exhibited by the terminal segments in each family and genus that I have been able to examine are noticed in natural order. It seems to me that these features, although unfortunately only existing in the ♂ sex, afford far better characters for classification than the neuriation of the wings, which have formed the basis of the arrangement of the Fossores, &c., which we now use. We know how subject neuriation is to vary, and how often specimens are found with one or more nervures of the wing imperfect or missing; also how in a series of specimens of one species a certain nervure will vary in its exact relative position to another; also how in *Tropoxylon* there are several cells merely indicated, as it were, by the very faintest nervures, besides those enclosed by nervures of the ordinary size, so that classing it by the ordinary nervures it takes its place amongst the genera having only one submarginal cell; whereas, if the entire system of neuriation be admitted, it would come amongst those with two.

There is, I think, also very grave doubts whether the insect we know as *Pompilus pectinipes* is more than a variety of the ♀ of *Evagethes bicolor*, with three submarginal cells instead of two, which is the characteristic of the latter genus. Certain it is that the two forms often frequent the same locality, and that the ♂ of *pectinipes*, the ♀ of which is far from rare, is unknown to us (the ♂ which F. Smith refers to it is that of *chalybeatus*); and specimens have occurred with three submarginal cells on one side and two on the other. All these variations in neuriation make it to my mind a very dubious character for classificational purposes, and, if the characters derivable from the terminal segments could be used instead, I think they would probably afford a more natural arrangement, and be far more constant. I say this after carefully observing that a certain type of segments will run through a whole genus,

modified only according to the species, but perfectly distinct from those of the allied genera; and also that, in like manner, a general similarity of form will run through a whole family. Certainly the adoption of these characters brings genera together in accordance with those derivable from general outline facies, &c.,—in fact gives what appears to be a natural arrangement.

Regarding an aculeate hymenopterous insect theoretically as a twenty or twenty-one segmented creature, six or seven of these segments, according to which view is adopted, are represented at one apex in the combination which we call the head, which bears various pairs of appendages denoting the existence of the segments. At the other apex of the creature two segments, I believe, are represented in what is called the genital armature of the ♂, the 9th abdominal segment beyond the basal constriction, *i. e.*, not reckoning the propodeum of Newman, being represented by the "cardo" of Thomson, and its appendages by the stipites, the 10th being represented dorsally by the spatha, and its appendages by the sagittæ; the 8th segment of the abdomen also in some genera bears appendages dorsally, as if it also were tending to join the combination. Now, as the shapes and appendages of the head-segments are regarded as amongst the best and most constant for generic classification, I think there is good reason why the shapes of the modified segments and appendages which compose and surround the armature should have equal value.

Of course no single character should be employed to the exclusion of others, and, without extending one's observations to the many exotic genera which I have been unable hitherto to examine, it is impossible to say how far these characters will prove constant. Still, from what I have been able to examine, I have little doubt that they afford a good basis for classification, and that the extension of one's observations would show that a classification on these sexual characters would produce a far more natural arrangement than the one we have at present in use.

The great difficulty to be contended with is that of obtaining subjects for dissection, and I should be most thankful to any one who can give me old specimens of exotic aculeates, however broken, for that purpose, *i. e.*, so long as the apex of the abdomen remains.

I now propose to give a list of the families and genera which I have examined, with remarks on the special characters of each, as exhibited in their apical segments and armature. Of these latter Dufour, in his 'Recherches Anatomiques,' &c., has already described a good many, and his paper is a most important one to anyone working on this subject. I may remark that his "hypotome" is the 8th ventral segment; his "forceps," the pair of stipites; his "baguettes du fourreau," the sagittæ; his "volselle," the lacinia of the stipes; his "piece basilaire," the cardo; he only mentions the spatha as the central piece of the "fourreau de la verge." In the following descriptions I have adopted the nomenclature of C. J. Thomson, viz.:—*Cardo*, the basal portion, in which the two *stipites* or outer forceps move; *Spatha*, the corresponding basal portion of the *sagittæ* or inner forceps, which, however, are often united into a single piece; *Lacinia*, the apical production of the stipes existing in many genera.

HETEROGYNA.—In this section the 8th segment is very distinctly represented in both valves, and is generally visible both dorsally and ventrally; the dorsal valve bears two lateral pilose appendages, which seem to have been noticed but misunderstood by some entomologists. Forel, in his 'Fourmis de la Suisse,' p. 13, regards them as part of the genital armature, calling them "penicilli." E. André\* also takes this view, calling them "pinceaux," and figures them protruding from under the 7th segment,† and remarks that they project from a square plate situated under the epipygium. In this latter statement he is quite correct, but he does not seem to have realised that this plate is the 8th dorsal segment, and in no way connected with the armature (see Pl. XIII., figs. 1, 1 a); in fact he says, at p. 13, that the abdomen of the ♂ is composed of seven segments. He also remarks that they are often wanting in *Myrmicocystus*. I cannot help fancying that their apparent absence must be due to the retraction of the 8th segment under the preceding. The most interesting feature in these little tail-like appendages is that they are not simple outgrowths from the segments, but are almost palpiform in their nature; being received into a

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\* 'Species des Formicides d'Europe,' p. 14. † Pl. I., fig. 12 a.

distinct fovea in the substance of the segment, they naturally remind one of the *Cerci* in the Orthoptera; but the latter occur on the 10th abdominal segment, whereas these (reckoning the propodeum) occur on the 9th. The "*Cerci*" of the *Tenthredinidæ*, however, occur on the 9th segment, and to these the penicilli above mentioned are, I think, clearly analogous. This character appears to run through the entire section.

**Fossores:** *Mutillidæ*.—Here, again, the "penicilli" occur, at any rate in *Mutilla* and *Myrmosa*; and as they occur also in *Myzine* I think it very probable that this last genus should be removed from the *Scoliidæ*, and placed here. The 8th ventral segment in both *Methoca* and *Myzine* is very plainly visible, and bears a peculiar upturned process, very different from the apical armature of *Scolia* (see Pl. XIII., figs. 2, 2 a, 3, 3 a, 3 b), &c. *Myzine* also lacks the reniform shape of the eye observable in the *Scoliidæ*.

*Scoliidæ*.—In this family (see Pl. XIII., figs. 4, 4 a, 4 b) I can find no trace of appendages to the 8th segment dorsally; in most species it is produced and somewhat rounded in the middle, but the ventral valve of the 8th segment is conspicuously exposed, and armed generally with three strong elongate prongs. The *Scoliidæ* bear a most striking resemblance in this armature, and also in the genital armature, which has the stipites flattened and dilated, to the *Bembecidæ* and *Nyssonidæ* (see Pl. XIII., figs. 12, 12 a, 14, 14 a); and I cannot but think that the position of these latter in the arrangement should be transferred from where it now stands to an earlier place in the section.

*Tiphidæ*.—No apparent penicilli; 8th segment beneath with an upturned process (see Pl. XIII., figs. 5, 5 a). To my mind a very distinct family from the preceding, the ♂ having the genital armature laterally compressed, and the cardo apparently produced above, and enclosing the sagittæ.

*Sapygidæ*.—No apparent penicilli; 8th ventral segment simple; exposed ventrally.

*Pompilidæ*.—Penicilli distinct; it should therefore, to my mind, follow the *Mutillidæ* in arrangement; 7th segment beneath very short, and visible only as a shining spot at the base of the 8th; 8th exposed (sometimes mistaken for the 7th), very variable in form,

and affording excellent specific characters; armature with the cardo generally very long (see Pl. XIII., figs. 6, 6 a, 6 b). In *Ceropales* the penicilli are very wide and foliaceous, not constricted at the base, and not palpi-form, in fact are mere lateral productions of the apical margin.

*Astatidæ* (*Astata*).—This genus, alone of the section with short prothoraces, so far as my examinations have gone, has distinct penicilli (see Pl. XIII., fig. 8). This, I think, is very interesting, as in habits it certainly comes near *Pompilus*, and in general character will not agree with any other group. Thomson has created a family for the genus; and I certainly think its peculiarities warrant its adoption. Eighth dorsal valve exposed, truncate at its extremity.

*Sphegidæ*.—No penicilli; eight ventral segments exposed, 8th generally flattened and wide; armature very variable; cardo short; stipites often armed with strong spine-like bristles (see Pl. XIII., fig. 11).

*Larridæ*.—Eighth segment narrow ventrally, often emarginate at the apex; stipites of the armature subdepressed and rather wide, except in *Palarus* (see Pl. XIII., fig. 19), which would, I think, be well placed in a separate family, the 8th segment ventrally being rounded, and the stipites exceedingly long and narrow, and bent downwards, fringed with long apical hairs.

*Pemphredonidæ*.—Eighth dorsal valve simple, ventral valve armed with an exposed, recurved, or at least straight process; genital armature often with the stipites very thin, and overlapping at the apex.

*Mimesidæ*.—Almost identical with the preceding family.

*Bembecidæ*.—As above stated, very like the *Scoliidæ*. Eighth dorsal segment simple or bidentate, ventral segment with a single short spine, 7th segment much narrowed to the apex; armature with the stipites much flattened, and somewhat elongate towards the apex, which is rounded (see Pl. XIII., figs. 12, 12 a).

*Nyssonidæ*.—Very like the *Bembecidæ* in the shape of the armature; 8th dorsal segment simple, 8th ventral with a single apical spine or process; or in *Stizus* (see Pl. XIII., figs. 14, 14 a), *Stizomorphus* and *Bembecinus* with three prongs, as in *Scolia*.

*Mellinidæ* (*Mellinus*).—Eighth dorsal segment simple, 8th ventral with a short apical process; genital arma-

ture short; the apices of the stipites on their inner margins each with a wide membranous lateral production, the left-hand membrane folding over the right. In this form of armature this genus seems to stand alone.

*Cerceridæ*.—Eighth dorsal segment simple, 8th ventral bidentate; armature very variable, but with the stipites not flattened and dilated towards the apex (see Pl. XIII., fig. 7); 8th segment simple.

*Crabronidæ*.—In the genus *Crabro* the stipites are produced into a long membranous wing at the apex, and often may be seen projecting beyond the apex of the abdomen; and the cardo in many species is very long (see Pl. XIII., fig. 9). In *Entomognathus* and *Lindenius* the stipites are shorter; and in *Oxybelus*, although the cardo is long, the stipites are not wing-shaped, but simple and elongate. This last genus, however, I scarcely think belongs naturally to the *Crabronidæ*.

*Trypoxylonidæ*.—Terminal segments simple; armature with the cardo short; the stipites not wing-shaped.

The characters above noticed would draw together the *Heterogyna*, *Mutillidæ*, *Pompilidæ*, and *Astatidæ*, on account of the appendages of the 8th dorsal segment; the *Scoliidæ*, *Tiphidæ*, *Bembecidæ*, and *Nyssonidæ*, on account of the form of the armature, and the processes of the 8th ventral segment; the *Pemphredonidæ* and *Mimesidæ* would come close to the *Nyssonidæ*, on account of the apical process of the 8th ventral segment; the *Crabronidæ*, on account of their dilated wing-like stipites, also show a distinct relation to these families. The *Sphigidæ* and *Larridæ* seem to come together naturally, both as regards habits and structure. Still I wish to avoid offering any new arrangement until I have had the opportunity of examining more of the exotic genera.

DIPLOPTERA.—In this section the 8th segment is simple, and the armature is very similar in nearly all the genera, being very convex and highly polished; the stipites each bearing a long spine, which may be often seen in life projecting beyond the apex of the abdomen (see Pl. XIII., fig. 20). In *Vespa*, however, this spine is obsolete, or nearly so; the sagittæ are generally united. This section, to my mind, bears strong proof of the

value of the characters derived from the armature, as no one can doubt that it is one of the best and most natural groups that we have among the Hymenoptera, and throughout it the armature has a distinct character of its own quite unlike that of any other section.

ANTHOPHILA.—In this section more attention has been paid to the genital armature than in the others of the Aculeata, for, besides Dufour's excellent remarks, Schenck, Thomson, and others have used it with good results, as exhibiting characters for discriminating the species of *Bombus*. Morawitz has figured, in the 'Reise Turkestan von A. Fedtschenko,' the armature of several species of *Anthophora*, and v. Hagens, in the 'Berliner Ent. Zeits.' for 1874, has noticed and described the armature in many of the genera, besides using it as a character for the species of the genus *Sphécodes*. He speaks of the "zangen" or stipites as being "eingliedrig" or "zweigliedrig," his 2nd joint being the lacinia of Thomson.

I have adopted Thomson's nomenclature for the parts of the armature, as it seems to express very well what is wanted. The lacinia is merely a prolongation or branch of the stipes, and is often absent, and in some species it is difficult to know whether one should designate it by a distinct name or merely treat it as a process; still in many genera, such as *Bombus*, *Psithyrus*, &c., it is such a distinct feature that for descriptive purposes a special name is useful. V. Hagens, in his remarks (*loc. cit.*), mentions the "bauchsegmentverlängerung," and describes it; but it should be remembered that in *Andrena*, &c., this represents the 8th segment, whereas in *Anthophora* it represents the 7th. In *Halictoides* and *Dufourea* he mentions that the "bauchsegmentverlängerung" is prolonged into three points. Here he has evidently been examining the 7th and 8th together, as the 7th bears two lateral processes and the 8th one apical; but, clinging tightly together as these two plates do, it is in no way to be wondered at that v. Hagens should have been misled.

The lacinia is present in nearly all the genera with the exception of *Andrena* and of those in the subdivision *Dasygastre*, and, curiously enough, in the parasites or "cuckoos" of these latter; but this does not apply to the parasites of *Andrena*, viz., the species of *Nomada*, which have a distinct lacinia. Still it is worthy of note that there is often an extraordinary general similarity in

the apical segments and armatures of the parasites, and of the bees with whom they live: *Megachile* and *Cœlioxya*, *Chalicodoma* and *Dioxys*, *Anthophora* and *Melecta*, are rather striking cases of this similarity. Throughout the *Anthophila*, so far as I have been able to examine them, the hairs of the armature are branched or plumose, and the 8th dorsal segment is simple, fitting into the 7th, and of a horny submembranous texture.

*Prosopis* and *Colletes*.—In the *Obtusilingues* the 7th and 8th ventral segments have most interesting modifications. I have figured those of *Prosopis* in our 'Transactions' for 1882, Pl. VI., and those of *Colletes* are no less peculiar; the 7th is dilated at the apex into one or two wing-like appendages, very variable in form, according to the species; the 8th has a central apical process, hairy beneath at its apex; the armature in each genus is of a form peculiar to itself (*vide* volume of our 'Transactions' quoted above, Pl. VII.).

*Sphecodes* and *Halictus*.—In these two genera the 7th and 8th ventral segments are nearly simple; they lie hidden by the 6th at the base of the armature as two corneous plates, generally slightly produced and rounded in the centre; the armature has the stipites short and somewhat curved, with a distinct lacinia to each, the sagittæ bent downwards at the apex; in both genera the form of armature affords excellent specific characters (*vide* Trans. Ent. Soc. Lond., 1882, Pl. VIII., IX.).

*Nomia*.—In this most extraordinary genus the ventral segments of the abdomen are flattened and somewhat concave; the 8th is pale and corneous, truncate in the centre; the 7th is emarginate, with the sides of the emargination rounded and fringed with golden hairs; genital armature with a semicircular membranous apex to each stipes; the sagittæ raised and subtriangular (see Pl. XIII., fig. 18).

*Nomioides*.—In this little halictiform genus seven ventral segments are visible, and the 8th lies close under the armature, and is produced at the apex into an elongate process; the armature has the stipites elongate, narrow and somewhat curved, the sagittæ narrow and nearly straight.

*Andrena*.—In this genus the 7th ventral segment is

hidden beneath the 6th, and the 8th appears at the apex, being generally somewhat dilated apically and rounded or subtruncate; the 7th is sometimes emarginate in the centre of the apical margin. The armature is very little liable to variation in the genus, and except in a few species shows no important modifications. It has the stipites bent and arched over the sagittæ, and each flattened and more or less pilose at the apex (see Trans. Ent. Soc. Lond., 1882, Pl. X). *Andrena carinata*, Mor., is a notable exception.

*Macropis*.—This genus is most peculiar in its terminal segments (see Trans. Ent. Soc. Lond., 1882, Pl. X.), the 7th segment being subquadrate and fringed at the sides with a series of flattened spines; the 8th is produced at the apex into a subrotundate process, terminating in a sharp point; the genital armature has the stipites each terminating in two deflected furcate prolongations, very unlike that of the surrounding genera.

*Dasyпода* and *Cilissa*.—In both these genera the 8th ventral segment is exposed beneath as in *Andrena*, and dilated at the apex; the 7th is hidden and generally emarginate at the apex, with a lateral projection on each side (see Trans. Ent. Soc. Lond., 1882, Pl. XI).

*Panurgus*.—All eight ventral segments exposed in some species, the 6th being emarginate so as to show the 7th, the 8th projecting and dilated at the apex, as in *Andrena* and its allies; armature with the cardo very elongate (see Pl. V., figs. 1, 2).

*Panurginus*.—All eight ventral segments exposed; 7th slightly elevated, narrowed and bidentate at the apex; 8th with an elongated central process fitting into the emargination of the 7th segment, its apex slightly swollen and rounded; armature very like that of *Panurgus*, with the cardo very elongate.

*Dufourea*.—7th segment hidden, bilobate; 8th with a long straight central process, visible beyond the 6th; armature with the stipites pointed, the sagittæ distant at the base (see Pl. V., figs. 4—4 b).

*Systrophia*.—7th ventral segment consisting of a basal band, from which emerge two elongate processes somewhat curved, thickest in the middle and pointed at the apex, with an elevated ridge on each on the side nearest the armature (see Pl. XIII., fig. 13 a); 8th with an elongate apical process, bent upwards, and hairy beneath

towards the extremity, which is rounded and dilated (see fig. 13); armature short and stout, stipites with the apices rounded, and a distinct blunt spine (lacinia), projecting from beneath, beyond them (fig. 13).

*Halictoides*.—7th ventral almost exactly as in *Systropha*; 8th with the central process very long and bent upwards, dilated and thickened at the apex; armature with the stipites densely pubescent externally.

*Rhophitoides*.—In the form of the 8th segment and genitalia almost identical with the preceding, but, having broken the 7th in the only specimen I have been able to dissect, I cannot record its form.

*Rhophites*.—7th ventral segment with two elongate flat testaceous lateral processes, slightly widened at the apex; at the base of each externally is a shorter, small, curved process; 8th with a very long central process, as in the foregoing genera, densely hairy at the apex; armature, with the stipites, with a flattened lacinia; sagittæ widely separated at the base, and converging to the apex (see Pl. V., figs. 3—3 d).

*Biareolina*.—7th ventral segment simple; 8th with an elongate central process, truncate at the apex, densely clothed with hairs at the sides and beneath; armature with the stipites produced at the apex into a semi-circularly dilated lacinia.

*Nomada*.—The terminal ventral segments of this genus are most characteristic; the 7th is simple, and with the 8th is hidden; the 8th is generally produced in the centre into a long process, which is more or less incurved at the apex and armed with reflexed spines, varying greatly in number and form according to the species (see Pl. VI., VII). In some few species the segment is subtriangular, but still is armed with spines at the apex. The armature is rather quadrate in form, and the stipites largely and deeply emarginate inwardly, densely clothed on their lacinia with long plumose hairs; the sagittæ are narrow and covered with the membranous spatha nearly to the apex. Excellent specific distinctions can be obtained from these characters.

*Epeolus*.—7th segment truncate at the apex; 8th with a short central process, not spinose; armature with the stipites wide, and with wide lacinia not tufted with hairs; sagittæ very wide, united and produced in the centre into a narrow truncate process (see Pl. VII., figs. 9, 10).

*Biastes*.—7th and 8th segments hidden, 7th slightly

produced at the apex, 8th produced into an elongate process; armature with the stipites stout; laciniae long and very narrow; sagittae produced beyond the apex of the laciniae; spatha long, extending to about the apex of the laciniae.

Of the several other curious genera that are placed here I have been unable to procure specimens for dissection.

*Melcta*.—7th segment consisting of two elongate convergent rather narrow plates, which are united near the apex by only a thin membrane, so that in dissecting they often become separated; 8th subtriangular, pointed at the apex; armature large and massive; laciniae produced into a narrow pilose process (see Pl. VIII., figs. 1, 2).

*Crocisa*.—Almost as *Melcta*, but the laciniae of the armature are broader and set with strong bristly hairs.

*Cælioxys*.—The terminal segments and armature in this genus resemble very closely those of *Megachile* and the other *Dasygastræ*, the 6th dorsal segment terminates the abdomen, and the anal opening is inferior, the 7th dorsal being only visible beneath; only five ventral segments are exposed; the 7th is a mere membranous band, slightly thickened at each side, and almost certain to get broken in dissecting; the 8th is short and tongue-like, lying close under the armature; the armature itself has the stipites without laciniae, and their apices hairy, the sagittae covered with a membrane to their apex (see Pl. VIII., figs. 3—7).

*Dioxys*.—Similar to *Cælioxys* in the 7th and 8th segments, but armature clear testaceous-brown, highly polished and glabrous; stipites simple and narrow, slightly curved; sagittae widely separated, flat, and paler than the stipites, hamate externally at the apex; between the sagittae is stretched a membrane, which is clear at the sides and thicker in the centre (see Pl. XIII., fig. 16).

*Chalicodoma*.—Only four ventral segments clearly exposed; 5th with a squarish central scale-like spot at the apex; 6th narrow and submembranous, bearing a dense tract of hairs across its middle, each terminating in several finer hairs in *C. pyrenaica*. In *muraria* this segment has most remarkable characters;

at the sides may be remarked the usual recurrent angles, which are strong and horny; the segment is concave, membranous posteriorly, and only thickened anteriorly in a ridge running between the lateral supports, if they may be so termed; in the centre of this thicker portion, on its anterior margin, are two long recurved spines dilated at the apex; at each side, but at some distance from these central spines, are a number of finer spines with sharply truncate dilated heads; from these a thickened line runs diagonally on to the disk of the segment, bearing a number of simple spine-like hairs, which appear to be much thickened at the base; beyond the anterior spines is a subtriangular apical membranous production (see Pl. XIII., fig. 21 a). In *C. sicula* the 6th segment has a strong semicircular ridge dividing the more membranous parts across the disk; in front of this at each side is a thick fascicle of somewhat twisted, flat, ribbon-like hairs, so densely matted together that it is difficult to see one separately; beneath these, on the ridge running from them on to the concave anterior portion of the segment, are a number of fine simple hairs, on thickened bases; 7th segment narrow and membranous; 8th tongue-shaped, with a basal angle at each side; armature clear testaceous-brown, glabrous, highly polished; stipites long and narrow, nearly straight, widened at the apex into a broad internal hama; sagittæ straight, widely apart at the base, converging to the apex, with a membrane covering the space between them (see Pl. XIII., fig. 21).

*Megachile*.—Very like *Chalicodoma* in character; the 6th segment membranous, and bearing hairs or spines of different forms across its centre, its apex sometimes terminating in a wing-like process; armature with the stipites more or less straight, generally divergent at the apices, which are nearly simple; no distinct lacinia, but the apex of each stipes in *maritima* is bifurcate; stipites very large at the base, and enclosed by a ring-like cardo; sagittæ simple, united by a membrane (see Pl. IX., figs. 1—7).

*Diphysis serratula*.—The armature of this insect is quite unlike that of *Osmia*, in or near which genus it has been usually placed: it has almost exactly the same form as that of some of the species of *Anthidium*, next to which genus I should propose to place it; the white clypeus of the ♂ also favours this view, which is held

also by Professor Perez, 'Contr. à la Faune des Apiaries de France,' p. 89.

*Anthidium*.—Apical segments very variable in form; 8th sometimes with a narrow apical process, sometimes tongue-like, as in *Megachile*; 7th sometimes rounded at the apex, with long recurrent basal angles, sometimes merely a transverse band with short recurrent angles. In *strigatum*, Pz. = *contractum*, Latr., the 6th segment is produced into a strong central spine, and in *flavilabre*, &c., has lateral comb-like processes (see Pl. XIII., fig. 15 a); armature with the stipites short and curved inwards at the apex in some species; in *laterale*, on the other hand, they are slightly divergent, and approach more to *Megachile* in form; in *strigatum* they are foliaceous; and in *flavilabre* widely triangular. These segments evidently exhibit strong specific characters in this genus, and would probably serve well to divide it into subgenera (see Pl. X., figs. 3—3 a; Pl. XIII., figs. 15—15 a).

*Stelis*.—7th and 8th ventral segments simple, the 8th being very slightly produced and rounded in the centre; armature with the stipites each suddenly thickened at the apex into an angular, four-sided, truncate club, bent inwards towards each other; sagittæ simple, slightly convergent (see Pl. X., fig. 2).

*Chelostoma florissomne*.—7th ventral segment bilobed; 8th triangularly elongate; armature with the stipites long and straight, enlarged at the apex of each into a pointed club, hairy on its sides; sagittæ straight, convergent at the apex, with a central membrane extending to their apex; 5th segment fringed with curved spirally twisted or knotted hairs (see Pl. X., figs. 4—4 a).

*C. campanularum*.—This species, in the terminal segments, shows very distinct characters; the 7th segment has a slight pilose production on each side, united by a thin membrane; the 8th is short and subtruncate; the armature has the stipites very narrow and curved, not thickened at the apex; the sagittæ wide at the base (see Pl. X., figs. 5—5 b).

*Heriades*.—Very like *C. campanularum* in the form of the armature, but the 8th ventral segment is narrow and pointed; the 7th I have not been able to extract satisfactorily; 5th segment with a row of six or seven teeth on each side set on a square projection (see Pl. X., figs. 1, 1 a).

*Lithurgus*.—The 7th ventral segment in this peculiar genus is simply rounded at the apex; the 8th is widely truncate; the armature is extraordinarily small for the size of the insect; the stipites are large and swollen at the base, and produced at the apex of each into a long straight process; sagittæ wide at the base, then narrowed to the apex, each with an apical dilatation (see Pl. XIII., fig. 17).

*Osmia*.—Very variable as regards the number of ventral segments exposed, and probably divisible into many good subgenera; 6th segment simply hairy; 7th membranous or nearly so; 8th tongue-like, sometimes narrowly emarginate at the apex; armature with the stipites without lacinia, generally very straight and elongate, curved or angularly bent inwards at the apex, the apical portion more or less clothed with hairs, and occasionally slightly dilated at the angle; sagittæ straight or converging beyond the middle, sometimes united by a membrane at the base (see Pl. VIII., figs. 8—16).

*Anthocopa*.—Same as *Osmia*, but 7th segment distinct.

*Meliturga*.—7th ventral segment with two apical bidentate processes, united by only a very thin connection, recurrent plates wide and straight; 8th terminating in a narrow process, widened into a spoon-like dilatation at the apex; armature with the stipites wide at the base; lacinia long, narrow, and pointed; obliquely truncate, viewed sideways; sagittæ short, blade-like, divergent at the apex (see Pl. XIII., fig. 10).

*Eucera* and *Tetralonia*.—In these two genera the style of the apical segments and armature is almost similar; the 7th ventral segment is emarginate in the centre, and is produced and raised at each anterior angle into two or three tubercular processes; the 8th is rather wide, and more or less truncate at the apex; armature stout, with the stipites terminating in a long narrow lacinia, often dilated at the apex; sagittæ widely triangular beyond the middle, and externally hamate (see Pl. X., figs. 6—6 b).

*Habropoda*, *Anthophora*, and *Saropoda*.—7th ventral segment with a more or less square apical plate, or produced at the apex into a variously-shaped process, rarely simply truncate; 8th short and usually five-sided; the apical margin often with two slight projections bearing

a few apical hairs. In *Habropoda ezonata* the apex of the 7th has a distinct thickened transverse ridge, beyond which is a thinner, somewhat quadrate, appendage fringed with hairs; in *H. zonatula*, beyond the middle of the 7th, are two strong lateral spines, and the apex beyond is attenuated and finely truncate; armature in all three genera stout and squarish in form; stipites with very variable laciniaë; sagittæ thick, widely separated in the middle and converging at the apex, often dentate on their inner margins (see Pl. X., figs. 7, 8; Pl. XI., figs. 1—3).

*Xylocopa*.—7th ventral segment a simple narrow band; 8th of a somewhat quadrate form; armature in *X. violacea* nearly square; the stipites without distinct laciniaë, curved inwards at the apex; sagittæ subparallel, their apices dilated and flattened, bent downwards, and convergent.

*Ceratina*.—I have had great difficulty in finding the 7th and 8th segments in this genus, but I have a specimen of *chalcites* which shows a distinct submembranous band, uniting the two sides of the 7th dorsal, and crossing the armature beneath, which I take to be the 7th; the 8th is a very fine thin membranous plate, lying beneath the armature, and emarginate at the apex; the armature is short and stout; the stipites with somewhat narrow laciniaë, pilose at the sides and apex; sagittæ widely separated at the base, and converging to the apex (see Pl. XI., fig. 5).

*Psithyrus* and *Bombus*.—There is very little difference between these two genera in their armature, &c.; the 7th ventral segment is corneous and bears a few hairs at the apex; the 8th similar in texture to the 7th, but narrower and somewhat pointed; armature with distinct and very variously-formed laciniaë to the stipites, which are stout; the sagittæ are elongate and vary much in form, so that the armature affords excellent specific characters in both genera (see Pl. XI. and XII.).

APIS.—Quite unlike any other genus in the armature, which has the stipites wide and triangular (see Pl. XII., fig. 15), and the sagittæ hidden and separated from them, only to be discovered by dissection (see Pl. XII., figs. 15 a, 15 b); and the whole armature is of much the same consistency as the other segments of the body, instead of being hard and shining as in the allied genera.

## EXPLANATION OF PLATE XIII.

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- FIG. 1. *Formica rufa*, ♂ armature.  
 1 a. ,, ,, 8th dorsal segment, showing penicilli.  
 2. *Mutilla europæa*, ♂ armature.  
 2 a. ,, ,, 8th dorsal segment, showing penicilli.  
 3. *Myzine 6-fasciata*, ♂ armature.  
 3 a. ,, ,, 8th dorsal segment, showing penicilli.  
 3 b. ,, ,, 8th ventral segment.  
 4. *Scolia bicincta*, ♂ armature.  
 4 a. ,, ,, 8th dorsal segment.  
 4 b. ,, ,, 8th ventral segment.  
 5. *Tiphia morio*, ♂ armature.  
 5 a. ,, ,, 8th ventral segment.  
 6. *Pompilus viaticus*, ♂ armature.  
 6 a. ,, ,, 7th and 8th ventral segments.  
 6 b. ,, ,, 8th dorsal segment, showing penicilli.  
 7. *Philanthus coronatus*, ♂ armature.  
 8. *Astata boops*, 8th dorsal segment, showing penicilli.  
 9. *Crabro cribrarius*, ♂ armature.  
 10. *Melliturga clavicornis*, ♂ armature.  
 11. *Psammophila viatica*, ,,  
 12. *Bembex rostrata*, ,,  
 12 a. ,, ,, 8th ventral segment.  
 13. *Systropha curvicornis*, ♂ armature.  
 13 a. ,, ,, 7th ventral segment.  
 13 b. ,, ,, 8th ,,  
 14. *Stizus ruficornis*, ♂ armature.  
 14 a. ,, ,, 8th ventral segment.  
 15. *Anthidium flavilabre*, ♂ armature.  
 15 a. ,, ,, 5th ventral segment.  
 16. *Dioxys cincta*, ♂ armature.  
 17. *Lithurgus cornutus*, ♂ armature.  
 18. *Nomia difformis*, ,,  
 19. *Palarus* sp., ,,  
 20. *Odynerus parietum*, ,,  
 21. *Chalicodoma muraria*, ,,  
 21 a. ,, ,, 6th ventral segment.